3.4.2. Dynamic Position Accuracy

3.4.2.1. Purpose

The purpose of this test is to determine the position fixing accuracy of the OMEGA system within the extremes of the expected groundsite geometries.

3.4.2.2. General

As described in the navigation theory section, diurnal effects, ground conductivity effects (with the exception of attenuation over the polar ice caps) and the earth's shape effects are fairly predictable and are accounted for within the OMEGA computer. Near station modal interference, long range, directional ambiguity and polar cap attenuation effects are compensated for by automatically deselecting stations inside 200 to 500 nm, beyond approximately 8,500 nm and with propagation paths over the polar ice caps. The exact ranges vary from system to system and are determined and set by the designer. The exact values can be determined from the manufacturer documentation as can plots of the areas where stations are deselected due to polar cap attenuation. SIDs and PCAs are unpredictable for the most part, cannot be accounted for, and therefore cannot be tested for within the time and cost constraints of this test since a complete investigation would require testing over great periods of time and atmospheric conditions.

The performance degradation of the OMEGA due to three of the above effects will be specifically isolated in this procedure. The pilot is typically given an indication of the OMEGA stations in use on the OMEGA navigation display. The performance of the OMEGA in selecting and deselecting these stations due to near station modal interference, long range, directional ambiguity and PCA can be measured by noting the stations in use as the aircraft transits these areas. These effects can be isolated by assuming that the errors will not be significant as long as the selections are performed correctly. The measured accuracy can then be assumed to be influenced by some combination of the remaining effects discussed in the OMEGA theory section. The exact contributions will generally be indeterminate by this technique. The aggregate effects of errors in the internal compensation routines of the OMEGA computer and the uncompensable errors can; however, be assumed to be satisfactory as long as the total error is within mission relatable tolerances. Further testing, requiring more sophisticated data gathering techniques and instrumentation, will be required if the error is beyond these limits.

With the exception of the time dependent variations of the PCA and SIDs, the OMEGA errors are generally not dependent upon time as were the INS errors. The effects are generally dependent upon station geometry. The testing emphasis is then shifted from time dependency to placing the system in as many station geometry situations as possible. Maximum range airspeeds are used to maximize the number of different geometric relationships possible in a single flight. In addition, the data is generally plotted in the form of a north-south/east-west error scatter plot vice an error versus elapsed time plot. [Ref. 38:p. 4.22a].

3.4.2.3. Instrumentation

Data cards and an optional voice recorder are required for this test.

3.4.2.4. Data Required

Following an OMEGA initialization, record the stations in use and the displayed latitude and longitude. Immediately prior to takeoff, record the runway, runway location, stations in use, and displayed latitude and longitude. At each flyover point, record the selected stations, surveyed point identification, altitude, and OMEGA displayed latitude and longitude. After landing and rollout, record the runway, runway location, stations in use, and the displayed latitude and longitude. Throughout the flight, record any OMEGA alerts and note the latitude and longitude when stations are deselected for near station modal interference, long range, directional ambiguity and PCA. Record qualitative comments concerning the utility of the OMEGA displays/controls and navigation accuracy for navigating to and visually finding the surveyed flyover points. Record as notes a description of the weather conditions.

3.4.2.5. Procedure

Prior to the flight, plan a route that provides a flyover point each 5 to 15 minutes of flight time. Preflight planning of the flyover route is discussed in the navigation theory section. Plan and plot the route using normal low level visual navigation procedures as outlined in reference 59 "Trainee Guide for Visual Navigation". Choose an altitude that can be comfortably flown considering the maneuvering characteristics of the test aircraft, the experience of the pilot, the current weather conditions and the local terrain. Altitudes between 200 and 2,000 feet AGL are standard. Visual Meteorological Conditions (VMC) are required and care should be taken to choose a route clear of small airfields, areas of dense low level traffic, as well as areas of high bird activity. Generally, standard military VR routes are useful since the route planning has already been performed and scheduling/coordination is fairly simple. References 61 and 62 outline the VR structure and explain procedures for their use. Once a VR route is chosen, only surveyed points leading to and from the home airfield to the start and end point of the VR route need to be selected.

If possible, a route should be chosen to exercise the OMEGA ground station select logic for near station modal interference, long range, directional ambiguity and PCA. The manufacturer's handbook on the OMEGA's operation will provide charts of the points at which the stations should deselect and reselect due to these three effects. In many cases, flight time, cost and home airfield location will not allow this to be performed; however, an attempt should be made, if possible. For most tests within the continental United States, the North Dakota station will be used to check near station modal interference deselection, the Norway station will be best for checking PCA deselection and the Liberia station will be best for checking long range, directional ambiguity deselection.

Perform an OMEGA initialization test. When the initialization is complete, record the stations in use and then the displayed latitude and longitude. Following normal aircraft and airfield procedures, taxi to the takeoff area and at the time of takeoff, record the stations in use and the displayed latitude and longitude. Note the aircraft location on the runway at the time the position is marked. This position can later be used to obtain the actual surveyed latitude and longitude.

Perform a normal airfield departure, navigating to the initial flyover point. Select an airspeed near the maximum range airspeed at the test altitude and set this airspeed as early as possible. Attempt to maintain this airspeed throughout as much of the flight as possible. Use visual reference points as well as the test OMEGA and any other available navigation aids to find the first flyover point. The first point should be within 5 to 15 minutes of takeoff and each subsequent point should be at 5 to 15 minute intervals. Record the stations in use and the displayed latitude and longitude at each flyover point as well as the bearing and range to the point when the point is not directly overflown. Record any system alerts with the elapsed time as notes.

While navigating to the flyover points, evaluate the utility of the OMEGA displays/controls, utility of the OMEGA derived steering cues, as well as the integration of the navigation information with the aircraft as an aid in early visual location of the flyover points. After visual location, evaluate the accuracy of the cues until overflight and afterwards the controls, displays and cues as an aid for immediate navigation to the next point. The last flyover should occur 5 to 15 minutes before touchdown. Following touchdown and rollout, record the stations in use, runway location, latitude and longitude. Use the description of the runway location to again obtain the surveyed location from airfield charts. Taxi to a surveyed parking area and before shutdown, record the stations in use and displayed latitude and longitude. Record the displayed latitude and longitude when the OMEGA deselects a station for near station modal interference, long range, directional ambiguity or PCA.

3.4.2.6. Data Analysis and Presentation

For data where the aircraft did not fly directly over the flyover point, use the recorded bearing and range at CPA to find the actual latitude and longitude. Convert the bearing to the point to true bearing and then resolve the vector into north-south and east-west components. Next, convert the components into differences in latitude and longitude. In the north-west hemisphere, add the difference in latitude when the point is to the south of the aircraft. Add the difference in longitude when the point is to the west of the aircraft. Use the equations below:

$$T_{bearing}=M_{bearing}-V$$

$$\Delta_{Lat}=\frac{(\Delta nm)}{\left(1\ \frac{nm}{min}\right)} \tag{17}$$

$$\Delta_{Long}=\frac{(\Delta nm)}{\left[\left(1\ \frac{nm}{min}\right)(\cos(LAT))\right]}$$

Subtract the displayed latitude and longitude from the surveyed latitude and longitude or the offset corrected latitude and longitude as appropriate. Convert the latitude and longitude difference to nm using equation (21). Plot the data as a scatter plot of the east-west errors on the x axis and the north-south errors on the y axis. Since the errors are not time dependent, the data from a number of flights may be combined as long as the basic system set up does not change. The scatter plot may be statistically analyzed to determine the parameters quoted within the specific system specification for the OMEGA under test. Generally, a calculation of the mean error, standard deviation and Circular Error Probable (CEP) will be required. Reference 45 provides a good discussion of the techniques for determining these parameters. Relate the accuracy of the OMEGA to the requirement to perform non-maneuvering navigation during ferry missions and while ingressing from the base airfield to enemy lines and to the requirement for updating the aircraft INS to correct for drift.

Occasionally the pilot will overfly the wrong surveyed point. If a single point is grossly wrong while the others have a more predictable error, the individual point can be discounted. Often, the correct flyover point can be found by inferring the appropriate navigation error from the error of adjacent data points and the presence of other targets on the TPC used for navigation. In this case, the new surveyed point can be used and the data will not be wasted.

If system alerts are noted during the flight, check for significant change in the error data following the time the alert is noted. Thoroughly investigate any OMEGA alerts that imply degraded accuracy and do not result in a change on the error plot or a malfunction being found during ground checks. Alerts that do not result in degraded accuracy or problems being found during the ground checks should be related to the possibility of unnecessarily aborted sorties (false alarms).

Relate the utility of the OMEGA displays, steering cues and integration within the aircraft to the utility of the OMEGA as an aid for navigating to the target position and later returning to the home airfield and as an aid in updating the INS after it drifts. Compare the positions where the OMEGA deselects and reselects ground stations for near station modal interference, long range, directional ambiguity and PCA to the manufacturer's charts of the designed selection and deselection points. Relate any discrepancies of greater than 50 nm to the possibility of increased errors due to the applicable effect. Relate any change in the error during the periods where the OMEGA stations are incorrectly selected or deselected to the reduced effectiveness of the OMEGA as an aid for navigation and updating the INS.

Severe weather may interfere with the ground station signals and may thus degrade the dynamic accuracy. If the accuracy is poor and weather problems are suspected, repeat the test in clear weather conditions to confirm the problem source. Relate weather effects to the necessity to fly in the vicinity of adverse weather.

3.4.2.7. Data Cards

Sample data cards are provided as card 45.

CARD NUMBER ___

DYNAMIC POSITION ACCURACY

[AFTER PERFORMING AN OMEGA INITIALIZATION TEST, NOTE THE SELECTED STATIONS AND RECORD THE LATITUDE AND LONGITUDE. RECORD DATA AT THE TAKEOFF ROLL POINT. AFTER TAKEOFF, SET ___KIAS, CLIMB TO ____ FEET MSL AND ASSUME LOW LEVEL NAVIGATION TO THE FIRST POINT. NAVIGATE TO EACH FLYOVER POINT AND RECORD THE DATA. RECORD THE OFFSET FROM THE POINT, SYSTEM ALERTS AND DESELECTION POINTS AS REQUIRED. RECORD QUALITATIVE COMMENTS CONCERNING THE UTILITY OF THE NAVIGATION DISPLAYS, STEERING CUES AND NAVIGATION ACCURACY. RECORD DATA AFTER ROLLOUT AND BEFORE SHUTDOWN.]

SURVEYED ALIGNMENT LOCATION __________ __________

STATIONS IN USE ____

DISPLAYED WHEN SELECTED _________ __________

EXPECTED POINTS OF DESELECTION:

N. DAKOTA __________ __________

LIBERIA __________ __________

NORWAY __________ __________

NOTES:

Card 45: Dynamic Position Accuracy Data Cards

DYNAMIC POSITION ACCURACY

POINT	SURVEYED POSITION	DISPLAYED POSITION	STATIONS	ALTITUDE (FEET MSL)	NOTES:

Card 45: Dynamic Position Accuracy Data Cards (Continued)

DYNAMIC POSITION ACCURACY

DESCRIBE THE LOCATION OF THE ROLLOUT:

SELECTED STATIONS AFTER ROLLOUT ______________________________

DISPLAYED AFTER ROLLOUT __________ __________

SURVEYED SHUTDOWN LOCATION __________ __________

SELECTED STATIONS AT SHUT DOWN ______________________________

DISPLAYED AT SHUTDOWN __________ __________

QUALITATIVE COMMENTS CONCERNING THE UTILITY OF THE OMEGA DISPLAYS/CONTROLS:

OMEGA STEERING CUES:

ACCURACY:

Card 45: Dynamic Position Accuracy Data Cards (Continued)